**VGI Communications Protocols Working Group**

**December 15, 2017 Draft Recommendation**

## Summary

To help enable vehicle-grid integration (VGI), the CPUC, ARB, CAISO, and GO-Biz recommend requiring a set of electric vehicle supply equipment (EVSE) hardware performance requirements for Level 2, conductive, alternating current, multi-user EVSEs deployed through ratepayer-funded investor-owned utility infrastructure projects. Based on Working Group feedback, we also identify leading communications protocols that can be layered on the hardware.

## Background

The Working Group has completed substantial portions of Deliverable 1 in the Work Plan. Based on the work to date, the CPUC, CARB, CAISO, and GO-Biz have made the following observations:

1. Based on Working Group results as of December 2017, at this time we cannot designate a single existing protocol that would best enable widespread, economic vehicle-grid integration. Markets, protocols, and technology are rapidly developing, and at this time we do not want to preclude any protocols or use cases that can deliver VGI value. While there are some use cases that do not require any high-level communications protocols and other use cases that can be enabled with a single protocol, others are possible only with a combination of protocols. Since we do not know the relative values of different use cases and have not prioritized use cases, we are unable to choose one protocol, or one combination of protocols, since we do not want to preclude any communications pathways that enable VGI.
    a. The Working Group found more time is needed to evaluate which VGI solutions will best accelerate EV adoption.
        i. Some automakers and service providers need a better understanding of the value of some VGI use cases to create a business case for implementing the hardware and software necessary to enable VGI at scale.
2. IOU Investments should minimize the probability of stranded assets that cannot participate in current and future VGI opportunities.
    a. Level 2 AC EVSE should be designed to be field upgradeable using software (e.g. over the air flashing).
    b. Level 2 AC EVSE should have the processing power to layer protocols that the Working Group has determined provide VGI-enabling functionalities, should the project host choose to implement them.
3. VGI-enabling hardware investments should be cost-effective and ensure long-term ratepayer benefits. Investments should:
    a. Minimize up-front investment.
    b. Maximize potential for grid benefits.
4. One of the goals of the Working Group is to gather data and document analysis that will help support State Agency decision-making regarding what policies we need to adopt to support VGI.

The agencies have considered every existing standard and non-standard communications protocol during the working group period.

**Recommendation**

Given our finding that it is premature to select a single protocol at this time, we recommend requiring hardware performance requirements that allow EVSEs to accommodate the multiple communications protocols that may be used to enable VGI. This approach combines the flexibility to ensure future usability with the certainty that manufacturers of charging stations need to invest in producing products. Based on Working Group discussions and data provided by EVSE providers, we expect the incremental costs of meeting the hardware performance requirements to be small.

Based on the Working Group results to date, CPUC, CARB, CAISO, and GO-Biz have developed the following recommendations to the CPUC on the IOUs' infrastructure investments. The goal of this recommendation is to identify the necessary EVSE hardware functionality that will enable the VGI use cases that stakeholders identified through the working group process. We acknowledge that hardware alone is not sufficient to enable VGI and that communications protocols will also be necessary. In addition to hardware and communications protocols, markets, tariffs, and policies will be necessary to enable some VGI use cases. Because we do not think it is appropriate to mandate specific communications protocols at this time, we document the recommended communications protocols for different domains of communication (Appendix A).

The scope of this recommendation is limited to Level 2, alternating current (AC), conductive, multi-user EVSEs due to the following:

- Level 2, AC justifications
    - The Working Group found that Level 1 EVSEs are unlikely to have a duty cycle that justifies the expense of enabling VGI in the EVSE hardware.
    - The Working Group found that there is currently more opportunity for VGI in long dwell time scenarios typically associated with L2 AC charging and not with DC fast charging.
    - The Working Group did not have enough time to fully evaluate what hardware may be required for best managing DC Fast Charging.
    - This proposal does not prohibit investments in DC charging technologies that can be designed or controlled to provide grid-integration functions.
- Multi-user justifications
    - Stakeholders expressed concern about the costs associated with all of the hardware requirements, and whether they are necessary for single-user EVSEs in residential or private workplace locations.
    - Public/multi-user EVSE have less predictable use patterns than residential and private workplace EVSE and can benefit from additional high-level communications.
    - Public/multi-user EVSE must be capable of providing pricing information and receiving charging instructions from multiple users.

- This proposal does not intend to apply to the design of an electric vehicle; therefore it does not restrict, limit, or determine the use of vehicle-based technologies (e.g. telematics) in providing grid integration functions between the Utility and EV.

**Table 1. EVSE Hardware Functionality Requirements**

| Domain of Communication | Hardware Functionality/Physical Layer | Description |
|---|---|---|
| **Power Flow Entity* to EVSE** | IEEE 802.11n compliance | Wifi connection |
| | IEEE 802.3 compliance | Ethernet connection |
| | Field upgradable | Ensures over-the-air updates are possible |
| | Sufficient processor power to perform real time protocol translation and encryption/decryption, supporting IP stack | |
| | Interface that provides hardware extensibility | |
| | Form factor that supports extensibility, via Internet Protocol version 6 | Use of IPv6 will allow for third party management of EVSE |
| **EVSE to EV** | HomePlug Green PHY for conductive EVSE | The physical layers that support the protocols the working group identified |

*The Power Flow Entity (PFE) includes Aggregator, Utility, EV Service Provider, Energy Service Company, Alternative Energy Supplier, Building Energy Management System, Energy Portal, and Clearing House.

We have identified hardware requirements between the EVSE and the PFE, and between the EVSE and EV. There is still opportunity for growth in each area and we understand that protocols specialized in each segment are necessary to enable a broader set of VGI controls by working in concert with the others. PFE to EVSE requirements are important because the agencies would like to avoid stranded assets and enable load management functionalities immediately. PFE to EVSE communications should use Internet Protocol to enable remote management and flash capabilities that allow over-the-air updates to each of the EVSEs when market forces dictate the change. The EVSE to EV requirements allow for VGI service functionality (e.g. ensuring vehicles are charged to meet drivers' needs) and cybersecurity measures.

Optionally, rather than including all hardware requirements on each EVSE, a utility may install an external protocol converter that controls multiple EVSEs. In this case, the external protocol converter must meet all of the hardware requirements identified in Table 1. Under this architecture, each EVSE

does not directly communicate to the third party, rather, the EVSE is part of a mesh architecture that communicates an individual EVSE's use to the external protocol converter.

The Working Group should determine what kind of documentation is necessary to show that an EVSE meets the required hardware functionality. This will allow the IOUs a clear and streamlined process for ensuring that any EVSE they support with ratepayer funding contains this functionality. Documentation could include certification sheets, parts list, or item data sheet.

While the Working Group has explored different metering requirements and cybersecurity requirements for the EVSE, we will need additional discussions in these areas. While these are two important components to fully enable VGI, we do not have enough information at this time to identify requirements in these areas.

## Appendix A: Recommended existing protocols that can help enable VGI in various communication domains

**Table 2. Recommended Protocols to Enable VGI**

| Domain of Communication | Recommended Protocols Currently Available* |
|---|---|
| **PFE to EVSE** | One or a combination of the following:<br>1. OpenADR 2.0b<br>2. IEEE 2030.5<br>3. OCPP 1.6<br>4. IEC 63110 |
| **EVSE to EV** | One or a combination of the following:<br>1. ISO 15118 v1<br>2. IEEE 2030.5 |
| **Vehicle OEM to EV** | Telematics (using proprietary protocols or IEEE 2030.5) |

* The Working Group recommends the current versions of these protocols, as listed here, serve as a minimum threshold. Future versions of the protocols are expected to also meet use case requirements. This table assumes that all EVSEs have J1772 pulse with modulation capabilities for low-level communications.

Based on Working Group discussions with communications protocols subject matter experts, the CPUC, ARB, CAISO, and GO-Biz identified the leading communications protocols that are currently available to support various communications domains. To enable VGI in the near term, we recommend implementation of these protocols in addition to the EVSE hardware performance requirements.